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smartE5 GmbH

smartE5 Energy Recovery System

ERS-Cube 640

Technical Data Sheet

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Approval	Technical Lead

1. System Overview

The **smartE5 Energy Recovery System (ERS) Cube** is a modular high-temperature heat recovery system for utilising flue gas heat from industrial combustion plants.

The system is integrated into the flue gas stream of a combustion plant and recovers thermal energy from high-temperature flue gases. The recovered energy is transferred via a high-temperature thermal oil circuit and can subsequently be used for a variety of energy applications. In combination with thermoelectric generators (TEG), part of the recovered heat can be converted directly into electrical energy.

The ERS Cube has a modular design and consists of several identical heat exchanger modules.
Thanks to its modular construction, the system can be flexibly adapted to combustion plants of different capacity ranges.

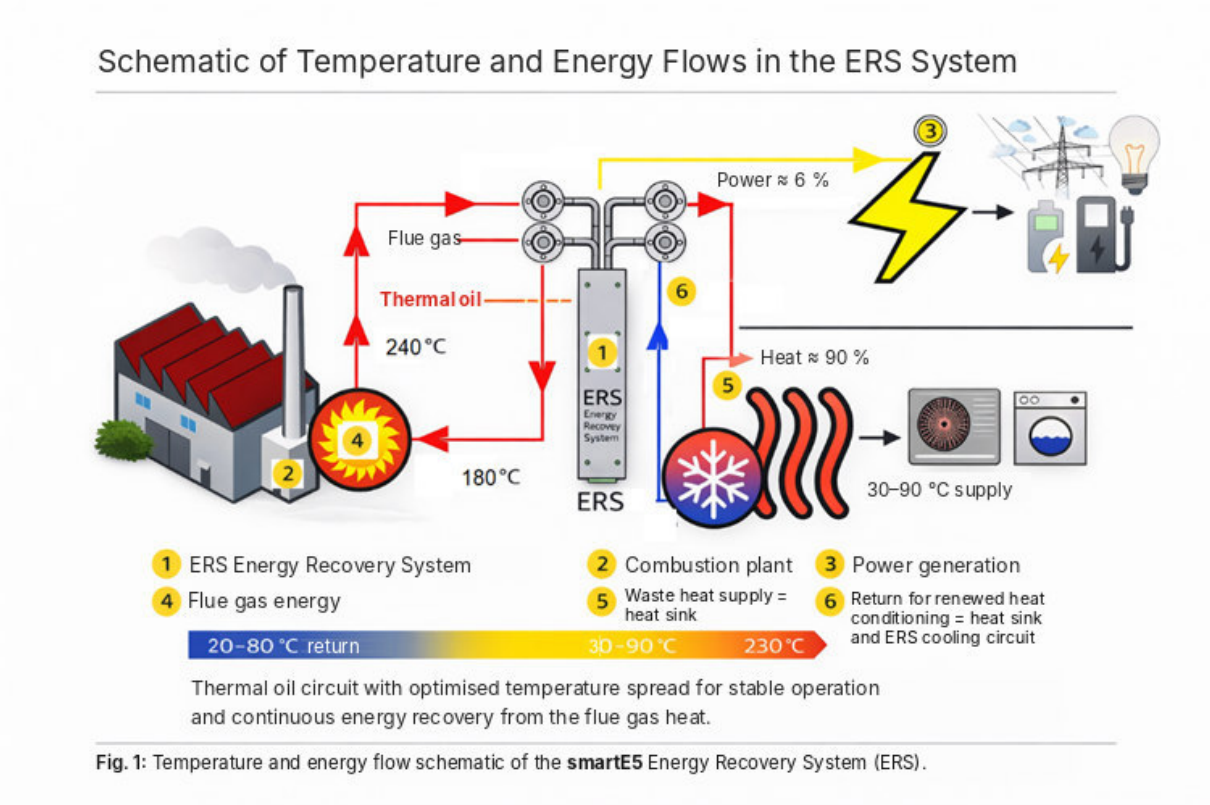


Fig. 1: Temperature and energy flow schematic of the **smartE5** Energy Recovery System (ERS).

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The smallest system unit consists of one heat exchanger module (HX) and requires a minimum thermal input from the flue gas stream of approximately **16.75 kW**.

Owing to the scalable architecture of the ERS Cube system, there is practically no upper limit to system capacity. Multiple modules can be combined into larger systems, allowing adaptation to a wide range of industrial applications.

The system is particularly suited to industrial combustion plants with capacities ranging from several hundred kilowatts up into the megawatt range.

2. Technical Specifications – ERS Energy Cube 640

The ERS Energy Cube 640 is a modular energy recovery system for converting industrial waste heat into electrical energy. The system is based on thermoelectric generators (TEG) and uses the temperature difference between hot side and cold side for direct power generation.

System Configuration

- One ERS Energy Cube 640 comprises 40 heat exchanger modules.
- Each module contains 2 aluminium heat exchanger vessels and 144 thermoelectric modules (TEG).
- Total number of TEG modules per Cube: 5,760.

Thermal Operating Data

Parameter	Value
Maximum hot-side temperature	+240 °C
Minimum cold-side temperature	−80 °C
Maximum temperature gradient	up to 320 K
Operating medium, hot side	Thermal oil
Operating medium, cold side	Water or glycol mixture

Mechanical Data

Parameter	Value
Cover plate	1,258 × 400 × 6 mm – aluminium EN AW-1050A
Contact base plate	1,200 × 320 × 3 mm – aluminium EN AW-1050A
Honeycomb plate	1,200 × 320 × 1.8 mm – aluminium
TEG module size	40 × 40 mm
Contact pressure force per module	approx. 3.2 kN
Total weight without enclosure	approx. 2,800 kg

Hydraulic System

Parameter	Value
Main manifold	Stainless steel manifold Ø 150 mm
Module connections	3/4-inch quick-release couplings
Coupling system	M22 × 1.5 plug-in system
Permissible operating pressure	≥10 bar
Pump system	Special-purpose pumps (NETZSCH) – approx. 12 pumps per Cube

Electrical System Data

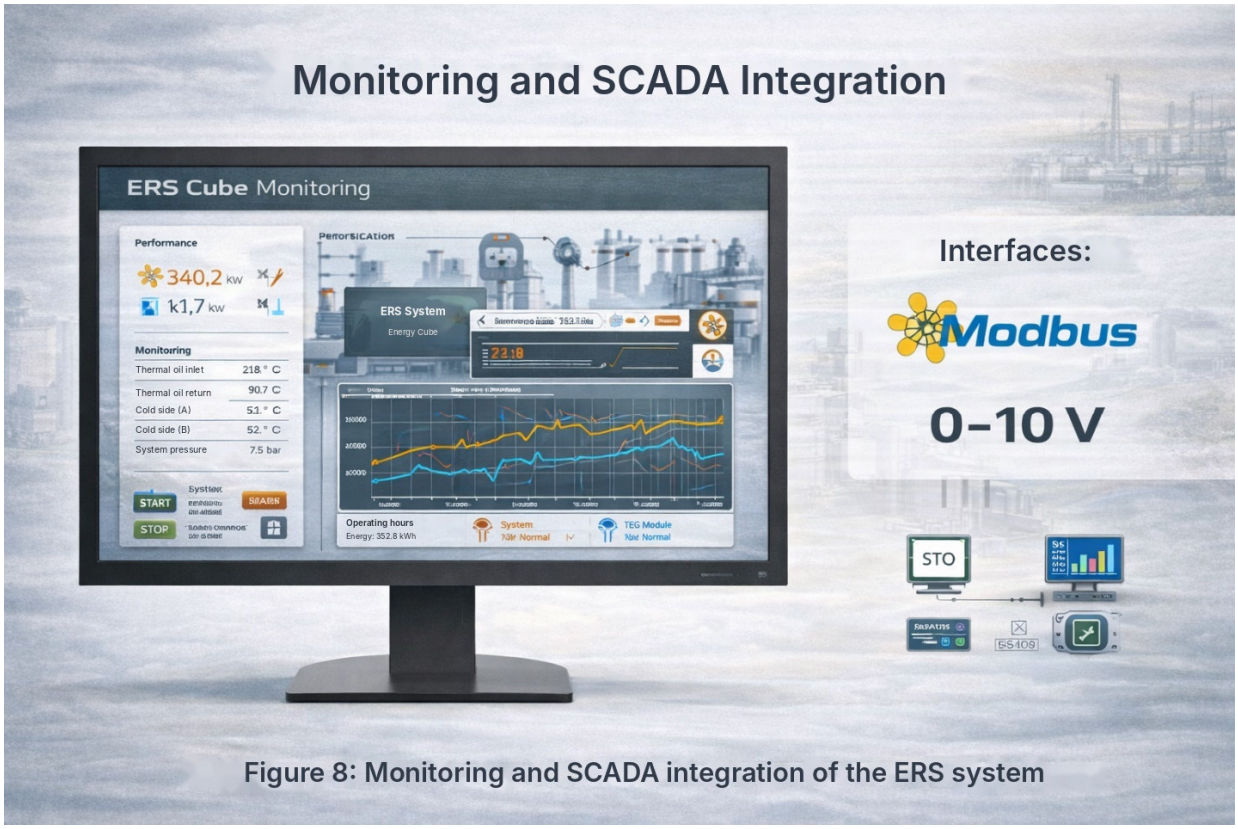
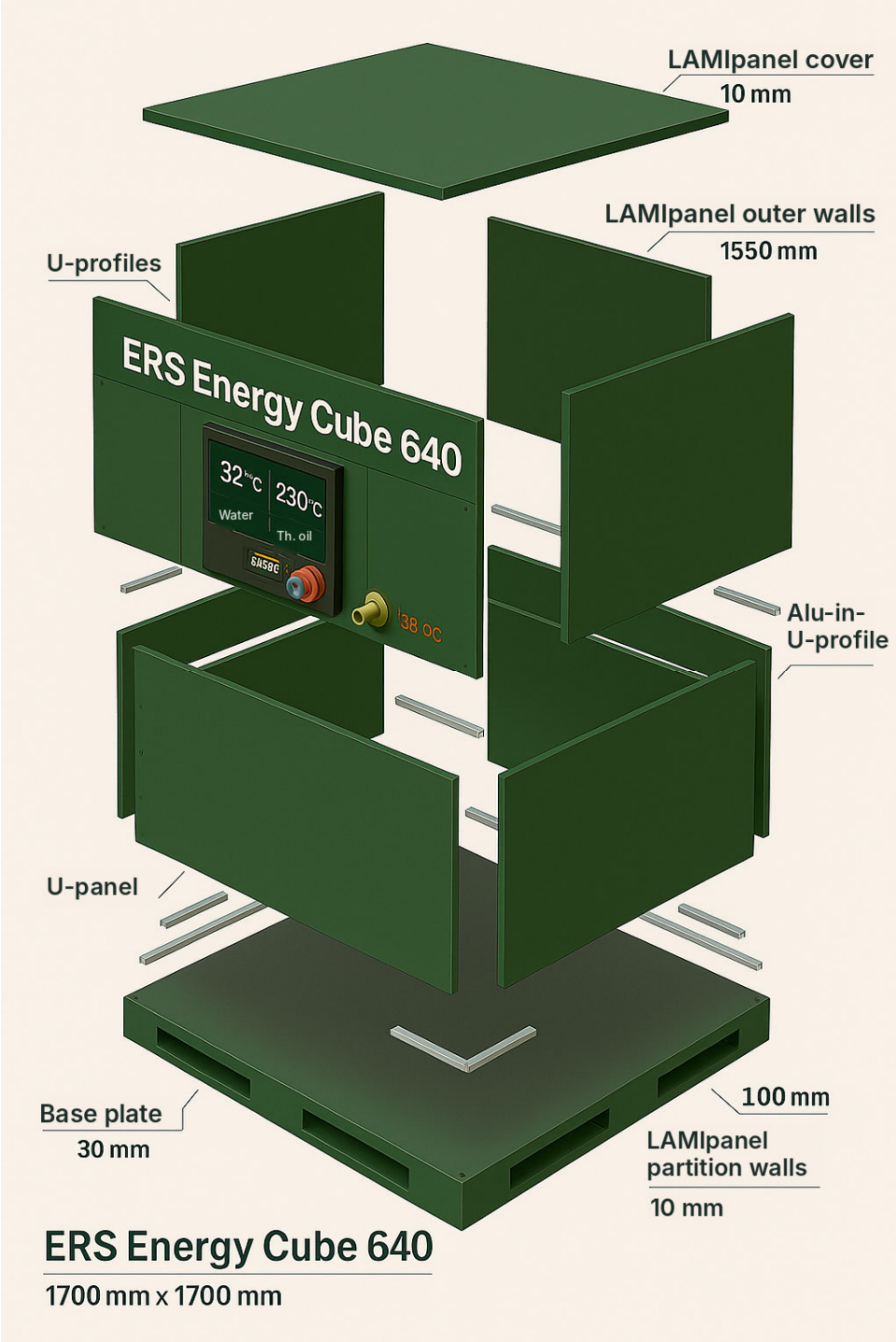


Figure 8: Monitoring and SCADA integration of the ERS system

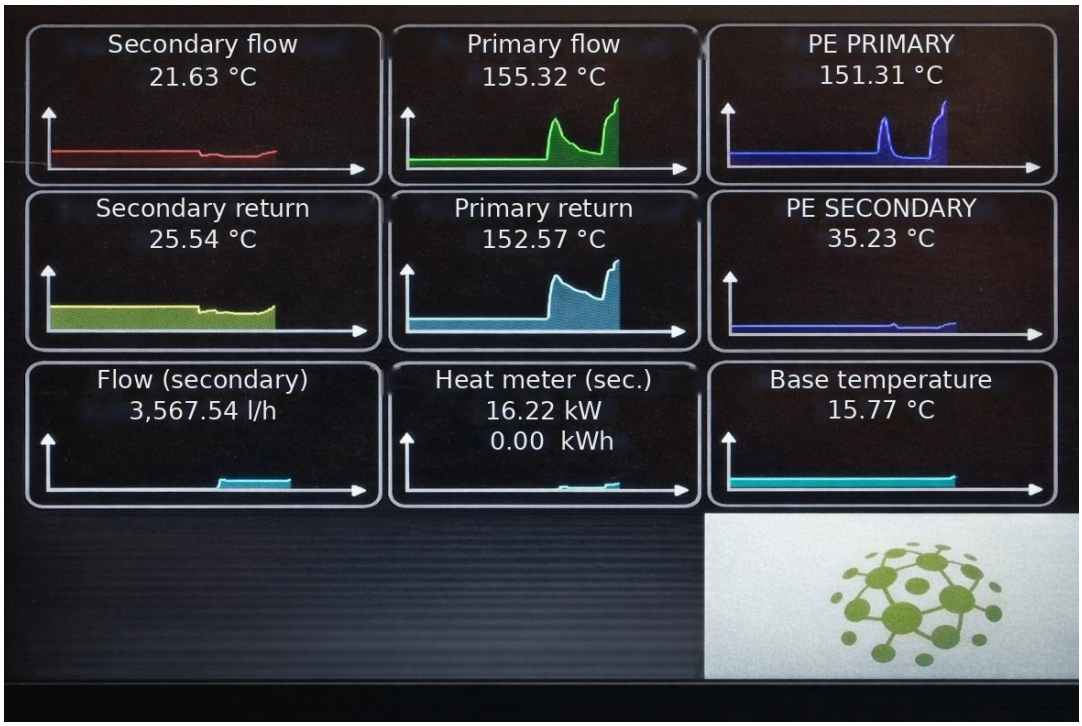
Parameter	Value
Generator principle	Thermoelectric modules (Seebeck effect)
Inverter	FOX ESS or Sungrow
Grid connection	230 V / 50 Hz or 400 V / 50 Hz
Interfaces	Modbus, 0–10 V, industrial monitoring
Monitoring	Integration into existing industrial or SCADA systems possible

Enclosure



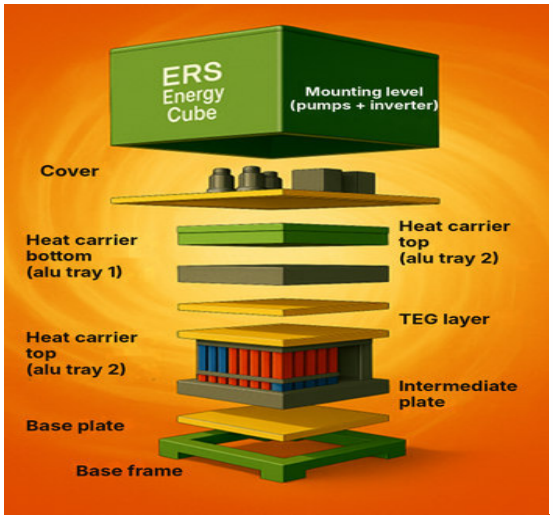
Enclosure made of LAMISkin PP 2000. The construction permits ambient temperatures of up to 100 °C and protects the components against industrial environmental influences.

Sensors



Temperature monitoring is performed by Pt100 sensors (Class A, M12 connector). Typical configuration: 4 sensors per module for monitoring the hot and cold sides.

3. Operating Principle of the ERS Energy Cube



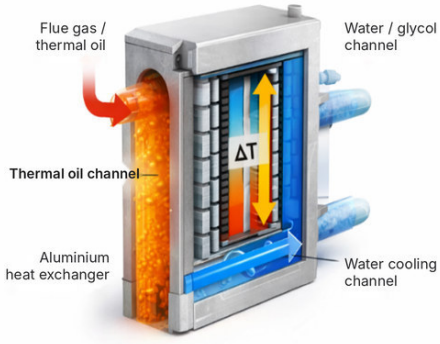


Figure 3: Design of the ERS Energy Cube 640

The ERS Energy Cube is a modular system for utilising industrial waste heat. The unit exploits the temperature difference between a hot flue gas stream and a cooler heat transfer circuit to generate electrical energy directly. Energy transfer takes place via specially developed aluminium heat exchangers. Thermoelectric generators (TEG) are installed between the hot and cold sides.
They convert the temperature gradient directly into electrical energy (Seebeck effect).

Process Sequence

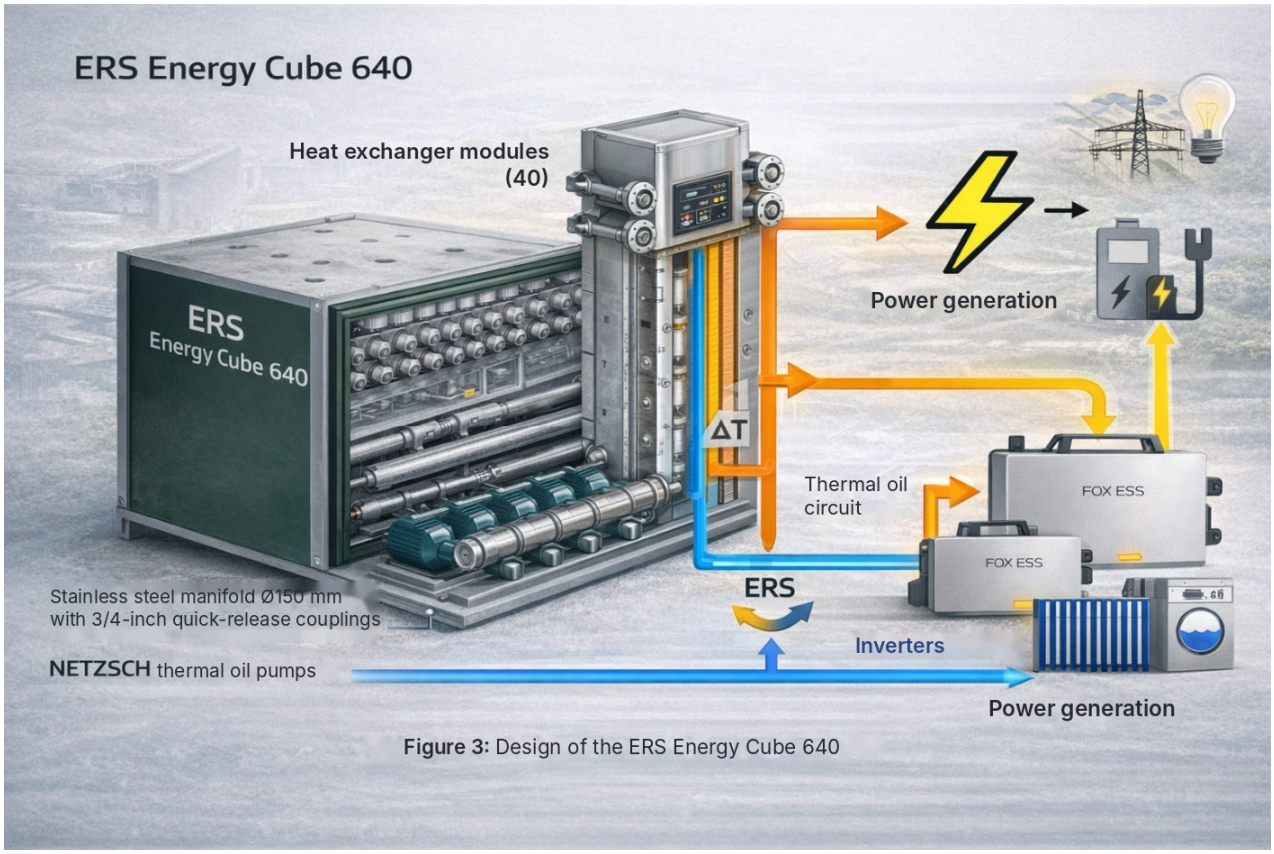


Figure 3: Design of the ERS Energy Cube 640

1. Waste heat from industrial combustion plants or process exhaust gases is transferred via a heat exchanger into the thermal oil circuit.

2. The heated thermal oil is distributed to the individual ERS heat exchanger modules via stainless steel manifolds.

3. Within the modules, a temperature difference is established between the hot thermal oil side and the cooled water side.
4. The thermoelectric generators convert this temperature gradient directly into electrical energy.

5. The direct current generated is converted by inverters into grid-compliant alternating current.

6. The electrical energy generated can be used directly on site or fed into the public grid.

7. The remaining heat is made available via the cooling circuit for heating systems, process heat or other industrial applications.

Temperature and Energy Flow

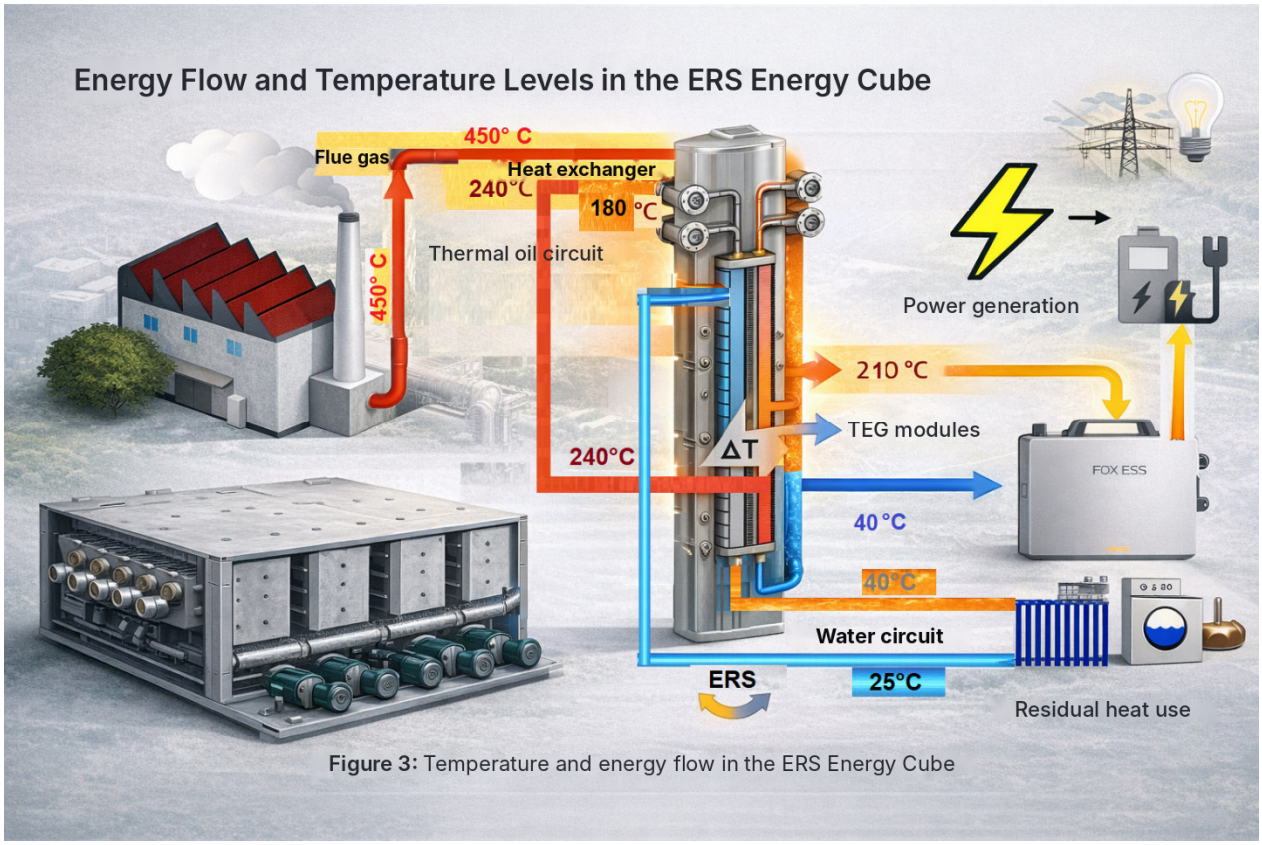


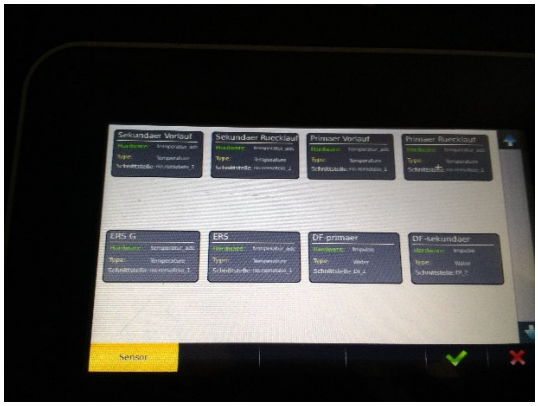
Figure 3: Temperature and energy flow in the ERS Energy Cube

The ERS Energy Cube operates most efficiently at high temperature differences between the hot and cold sides. Typical industrial applications provide temperature spreads of 150 to 190 kelvin.

Part of the thermal energy is converted into electrical energy, while the major share remains available in the system as useful heat.

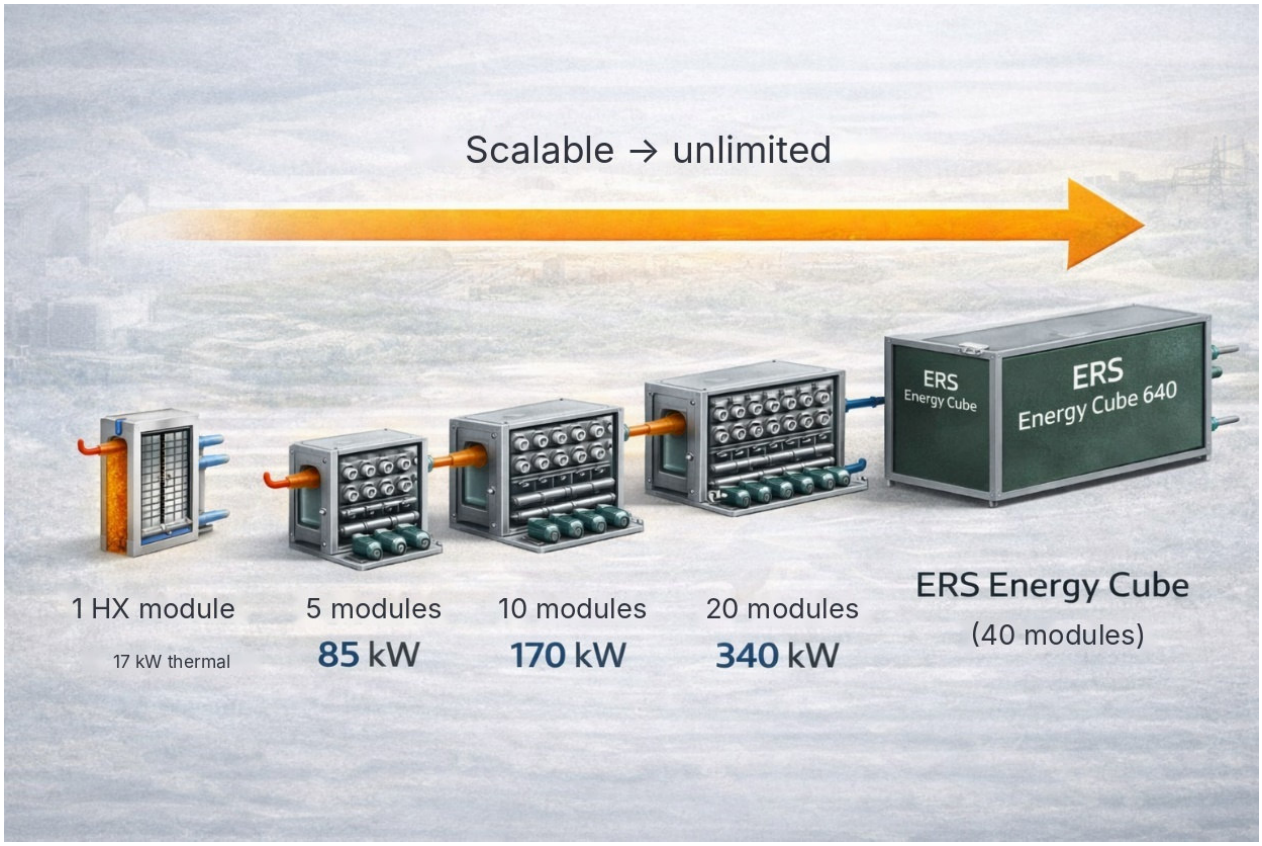
Combining power generation and heat utilisation enables particularly efficient use of industrial waste heat sources.





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System Advantages



• Modular expandability with no upper capacity limit

• Direct power generation without moving mechanical components

• High operational reliability thanks to the static generator design

• Flexible integration into existing industrial energy and flue gas systems

• Continuous energy recovery throughout plant operation

4. Energy Utilisation and Industrial Applications

The smartE5 ERS Energy Cube enables the combined use of industrial waste heat for the simultaneous generation of electrical energy and usable process heat.

Part of the thermal energy recovered from the flue gas stream is converted directly into electrical energy by thermoelectric generators. The major share of the energy remains available in the system as useful heat and can be used for industrial applications.

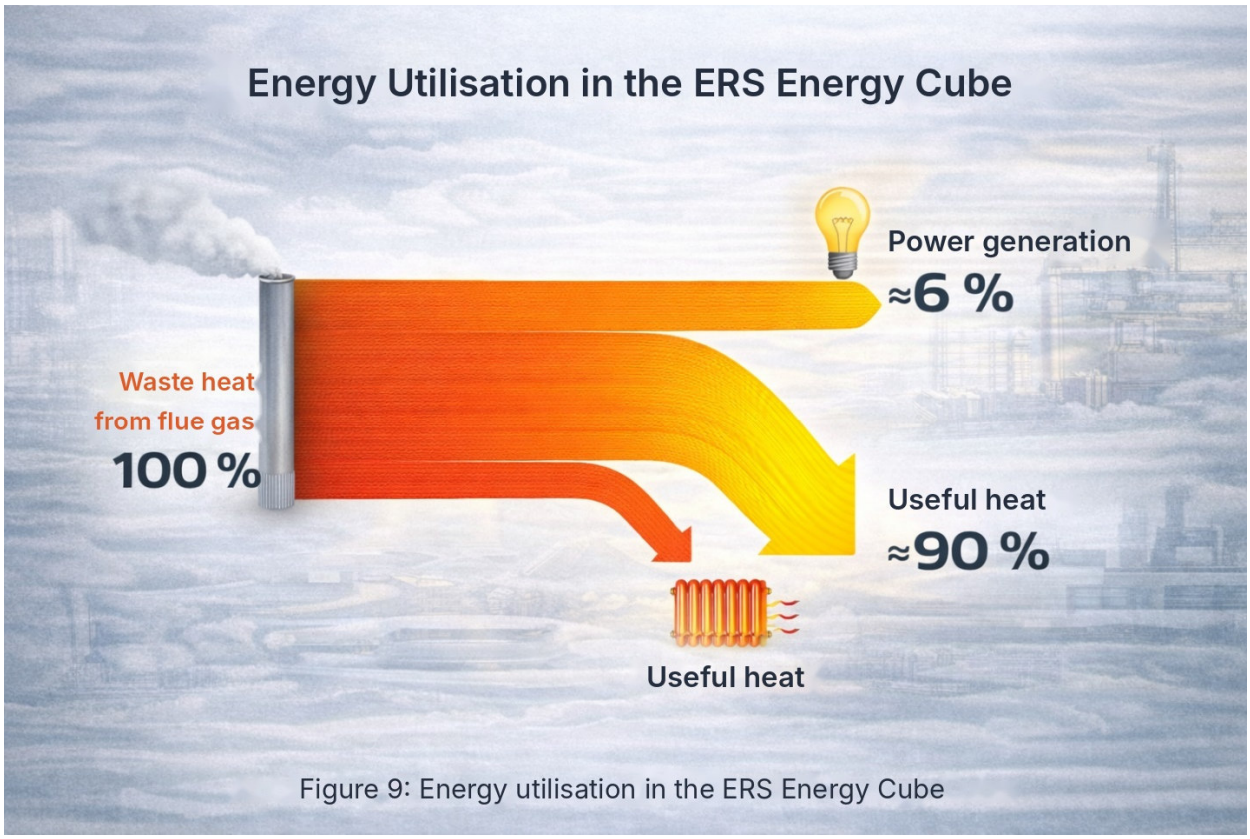


Figure 9: Energy utilisation in the ERS Energy Cube

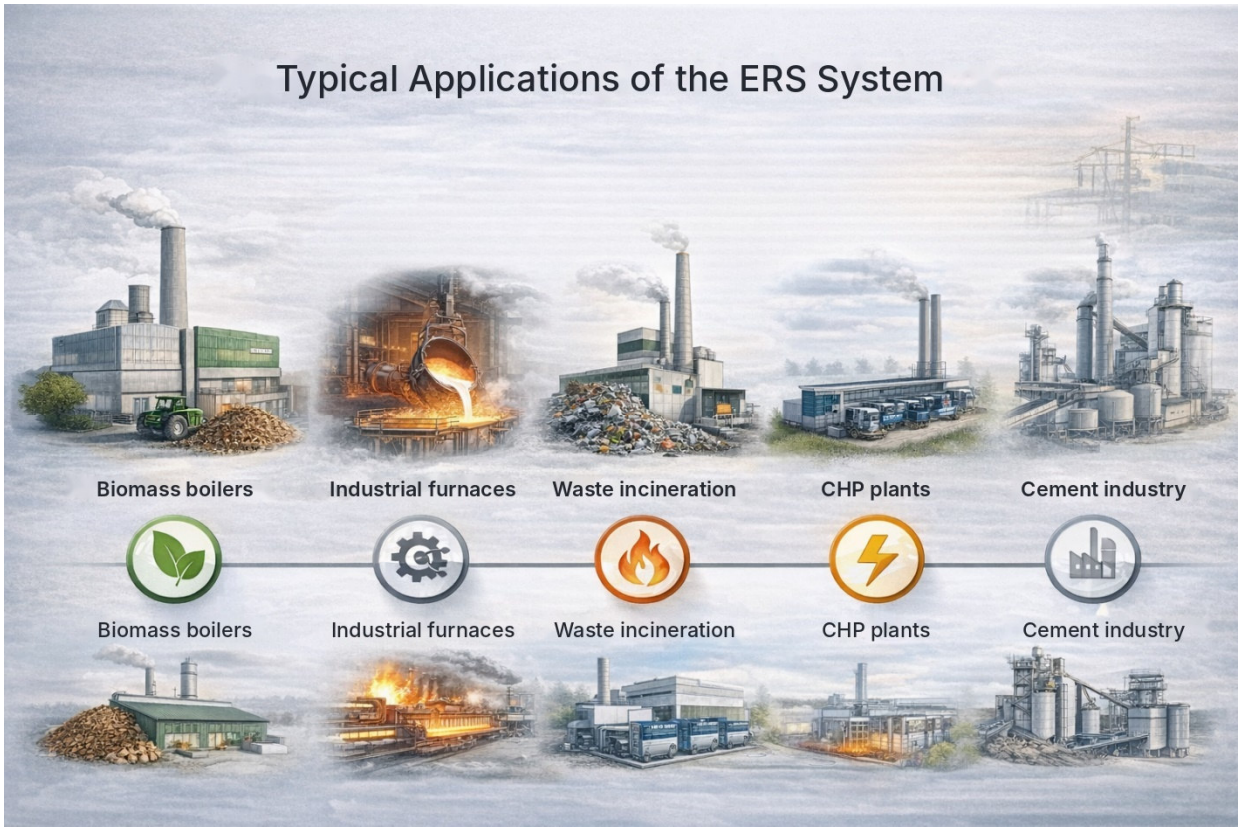
Relative to the waste heat supplied to the ERS, typically around 6 % is converted into electrical energy, while around 90 % remains in the system as useful thermal energy.

This combination enables particularly efficient use of industrial waste heat sources and significantly increases the overall efficiency of industrial energy plants.

The ERS Energy Cube can be deployed in a wide range of industrial applications, especially in plants with continuous high-temperature flue gas streams.

A. Typical Fields of Application

Biomass and industrial combustion plants
Steel and metal industry
Glass and ceramics production
Cement and building materials industry
Waste incineration and waste treatment plants
Industrial process heat installations



Thanks to its modular construction, the system can be flexibly adapted to different capacity ranges. The ERS Energy Cube is particularly suitable for industrial applications with flue gas temperatures ranging from 40 °C to above 450 °C.

5. Performance Characteristics and System Scaling

The smartE5 ERS Energy Cube is designed as a modular system.
By combining several heat exchanger modules, the thermal and electrical output can be flexibly matched to different industrial applications.

System performance depends essentially on two factors:

- the number of installed heat exchanger modules
- the available temperature difference between the hot and cold sides

As the number of modules increases, the total usable thermal output rises almost proportionally. At the same time, the electrical output generated by the thermoelectric generators increases.
In the maximum configuration of the ERS Energy Cube 640 with 40 heat exchanger modules, the following typical performance values are obtained:

• Total thermal output: approx. 686 kW
• Electrical output: approx. 41 kW
• Usable heat output: approx. 617 kW– at ΔT ≈ 190 K
In economic terms, the system's principal energy output is the recovered useful heat.
In addition, part of the energy is converted directly into electrical energy.

6. Technical System Limits and Integration Conditions

The smartE5 ERS Energy Cube is a modular waste heat utilisation system that does not rely exclusively on high absolute flue gas temperatures. The decisive factor for operating the system is the available **temperature difference (ΔT)** between the heat source and the heat sink.

Owing to the thermoelectric generator principle, the system can be operated over a wide temperature range. Energy conversion is possible even at comparatively low waste heat temperatures, provided that a sufficient temperature difference to the heat sink is available.

The ERS Energy Cube has three typical operating ranges.

A. Optimum Range – High-Temperature Applications

Temperature difference ΔT: **150–190 K**

Typical applications:

• industrial combustion plants
• biomass boilers
• waste incineration plants
• glass, steel and cement industries

In this range, the thermoelectric generators deliver their maximum electrical output.
At the same time, a high recovered heat output is available.

B. Economic Operating Range

Temperature difference ΔT: 70–150 K

Typical applications:
• industrial process heat
• power plant waste heat
• combined heat and power (CHP) units
• medium-temperature industrial flue gas streams

In this range, heat recovery remains high, while the electrical output decreases in proportion to the available temperature difference.

C. Low-Temperature Range

Temperature difference ΔT: 40–70 K. This operating range enables applications that conventional waste heat recovery systems often cannot address.

Typical applications:
• data centres
• industrial cooling circuits
• district heating networks
• low-temperature process heat
• low-temperature industrial waste heat streams

The ERS Energy Cube activates automatically as soon as a temperature difference of approximately ΔT ≥ 40 K is reached. If the temperature difference falls below this value, the system is deactivated automatically.

D. Operating Parameters

Parameter	Range
Temperature difference ΔT	from approx. 40 K
Optimum range	150–190 K
Number of modules per system	1–40
Total thermal output	up to approx. 686 kW
Electrical output	up to approx. 41 kW

The absolute temperature of the waste heat source may vary depending on the application. The decisive factor for energy conversion is always the available temperature difference between the hot side and the heat sink.

E. Maintenance and Service Life

Energy conversion in the ERS Energy Cube takes place entirely without moving mechanical components.

The system is based on a **solid-state generator principle**, in which thermoelectric modules convert the temperature difference directly into electrical energy.

This results in the following characteristics:

• no turbines
• no bearings
• no mechanical wear parts in the conversion section

The expected service life of the thermoelectric modules is **≥ 80,000 operating hours**.
The only moving components of the overall system are located outside the conversion section (e.g. the thermal oil circuit pumps).

7. Performance Diagrams

The following diagrams illustrate the performance of the ERS system as a function of the number of modules and the available temperature difference.

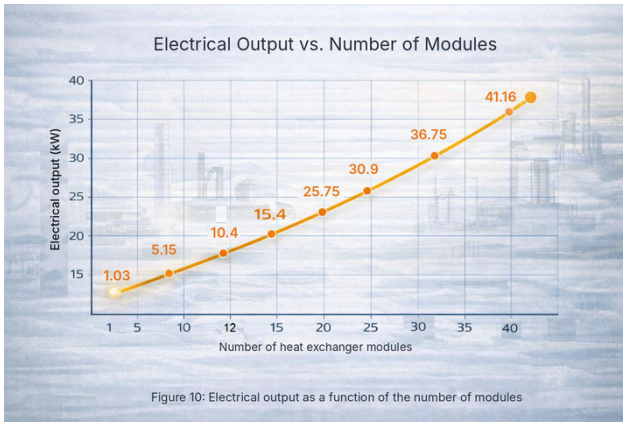


Figure 10: Electrical output as a function of the number of modules

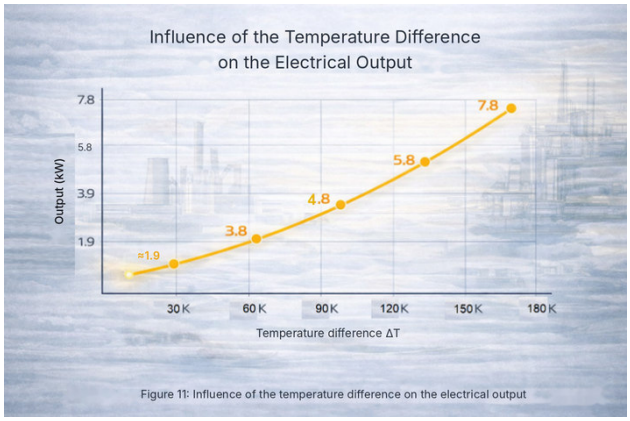


Figure 11: Influence of the temperature difference on the electrical output

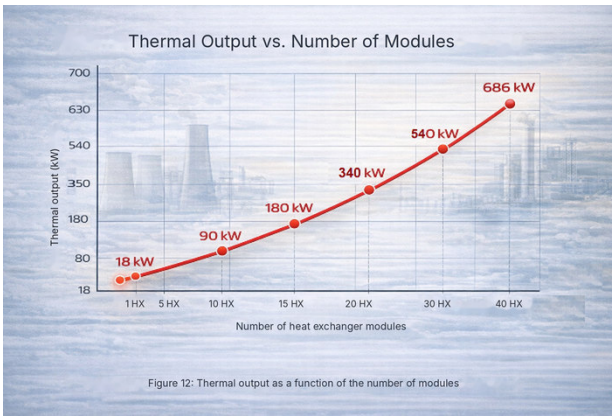
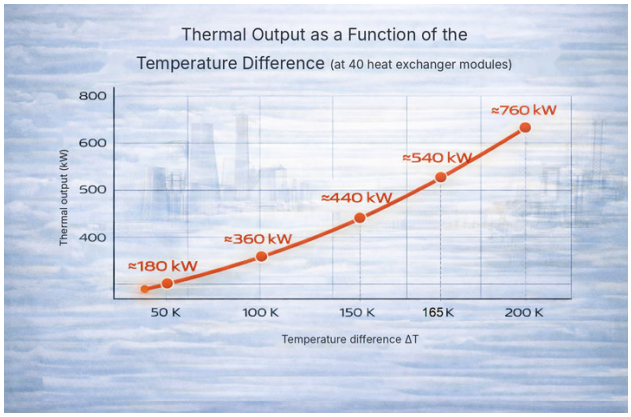


Figure 12: Thermal output as a function of the number of modules



8. Further Technical Information

Detailed technical descriptions, functional illustrations and calculation tools for the smartE5 Energy Recovery System are available on the manufacturer's platform.

This technical data sheet provides a concise overview of the key system parameters and performance data. More in-depth information on technology, applications, system design and project assessment is available from the following sources.

A. Technology and Operating Principle

Detailed descriptions of the thermoelectric generator principle and the system design, as well as an animated illustration of the energy flow in the ERS system, are available at the following link:
https://www.smarte5.com/technologie/

B. ERS Performance Calculator

An online calculation tool is available for estimating potential energy yields and for the project-specific assessment of
waste heat sources. This tool can be used to evaluate
parameters including the following:

- available waste heat temperature
- temperature difference to the heat sink
- possible number of modules
- electrical output
- thermal recovery output

The calculator can be accessed at the following link:
https://www.smarte5.com/rechner/

C. ERS Energy Cube Product Platform

Further information on the product platform, possible plant configurations and
typical industrial fields of application is available on the ERS Energy Cube product page.
https://www.smarte5.com/ers-energy-cube/

D. ERS 300 Product Platform

The ERS 300 product line is a compact system solution for utilising industrial waste heat, with electrical outputs of up to approx. 600 W and a thermal recovery output of up
to approx. 9 kW. Among other things, the system serves as a demonstration platform for applying the technology in smaller industrial applications. Further information is available at the following link:
https://www.smarte5.com/ers300/

Further information on media, partners, accreditations and technical publications
is available on the company website.

9. Technical Notes

The technical data and performance values stated in this document are based on typical operating conditions of industrial waste heat sources. The actual performance of an
ERS system depends on various project-specific parameters, in particular:

- available waste heat temperature
- temperature difference between heat source and heat sink
- volume flow of the waste heat source
- number of heat exchanger modules deployed
- operating conditions of the connected systems

For a project-specific design of the ERS Energy Cube, a detailed system analysis taking into account the respective process conditions is recommended. For this purpose, the
ERS Performance Calculator on the manufacturer's platform can be used, among other tools.

10. Technical Appendices

Appendix A – OEM Reference Data Sheet: ERS Cube 640

Appendix B – Integration Principle: ERS Bypass System

Appendix C – Performance Data: Heat Exchanger Modules (1–40 units)

Appendix D – Scenario Analysis: Heat Recovery (8%)

Appendix E – Scenario Analysis: Heat Recovery (15%)

Appendix F – Scenario Analysis: Heat Recovery (20%)

Appendix G – Technical System Description and Integration Guidelines

Subject to technical modifications in the course of further development.

All performance data refer to typical operating conditions and may vary depending on the respective process parameters.

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smartE5 ERS – Cube 640

OEM Data Sheet – White Engineering Edition

Integration: Heizomat RHK-AK (1000 kW reference boiler)

1. System Overview

The smartE5 ERS Cube 640 is a modular high-temperature bypass heat exchanger designed for integration between flue gas pass 1 and pass 2 of a biomass boiler. The system operates as an upstream thermal stage while the boiler's internal heat exchanger register is retained.



2. Technical Specifications

Number of heat exchanger modules	40 HX
Total thermal output	686 kW
Total electrical output	41.16 kW
Thermal oil supply	240 °C
Thermal oil return	180 °C
Temperature difference ΔT	60 K
Flue gas mass flow (reference)	603 g/s
Required chimney draught	10 Pa

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3. Flue Gas Parameters (1000 kW reference)

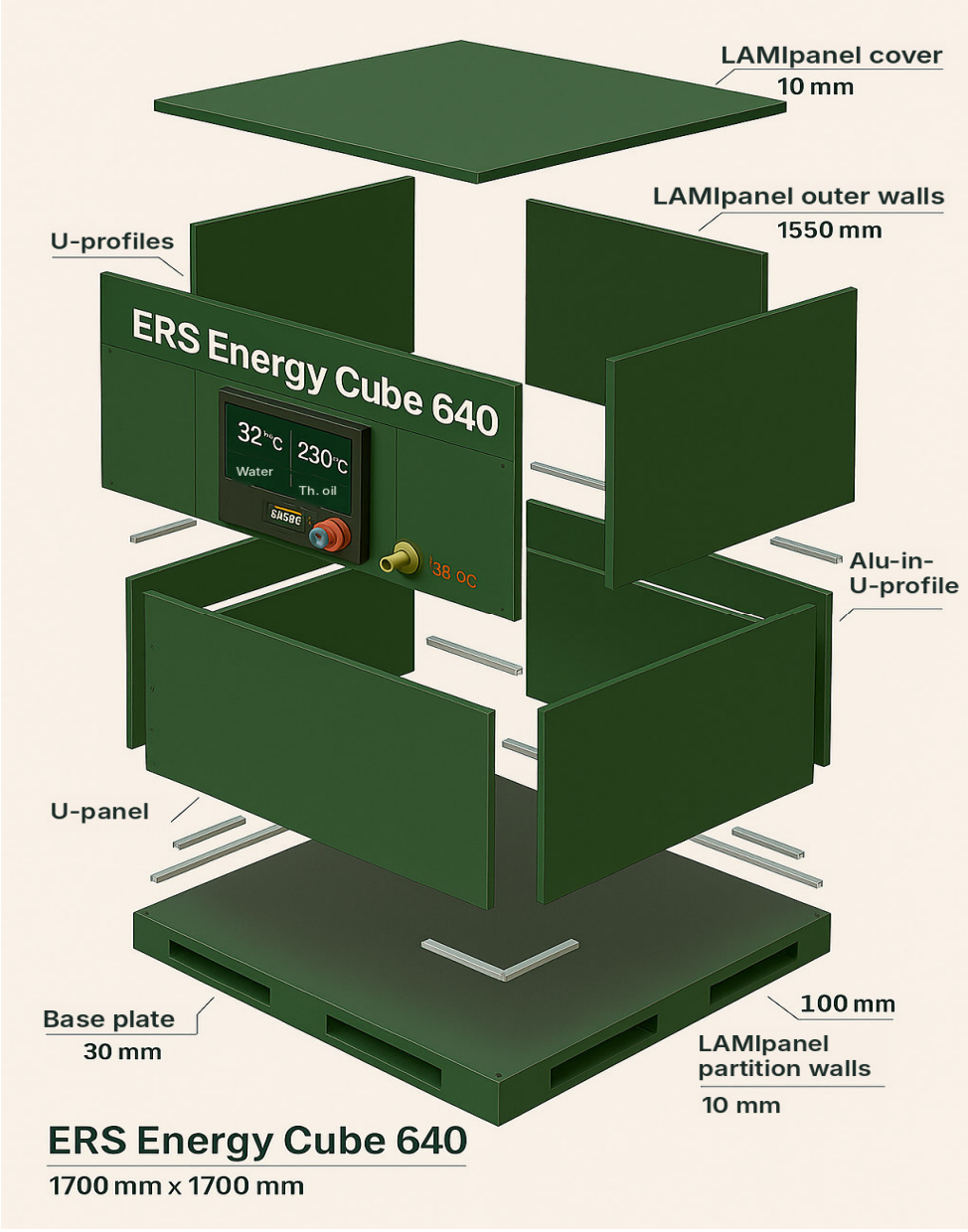
Flue gas temperature upstream of ERS: ~450 °C

Flue gas temperature downstream of ERS: ~250–300 °C

Flue gas temperature after internal register: ~120 °C

Minimum chimney temperature: ≥ 60 °C

4. ERS Cube Module Structure



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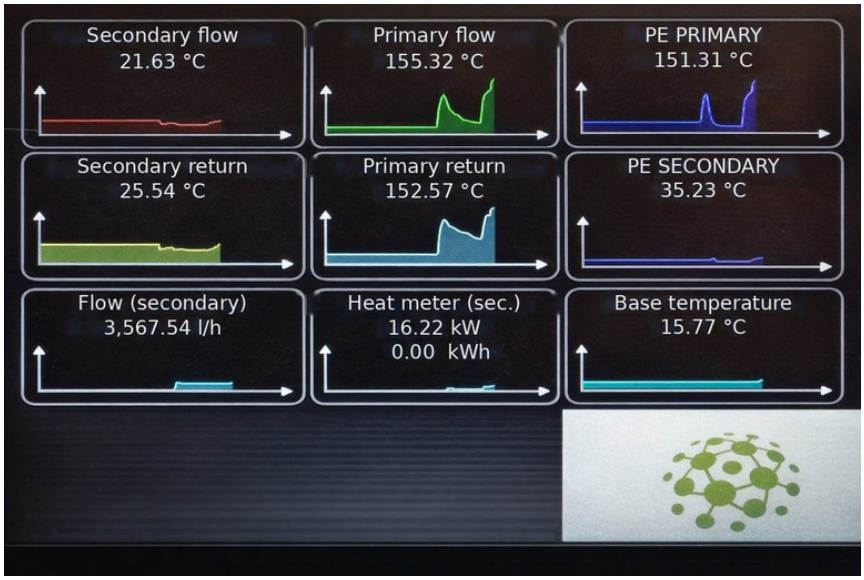
5. Hydraulic Integration

Thermal oil circuit with high-temperature supply at 240 °C and return at 180 °C. Output control via a modular bypass strategy.



6. Control & Sensors

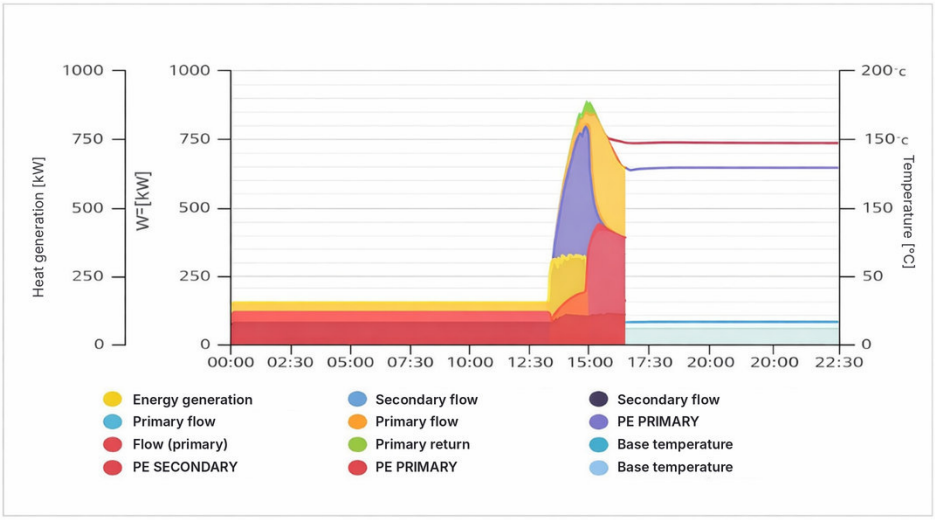
Visualisation of primary and secondary temperatures and flow rates, plus output monitoring, via the integrated HMI control unit.
Primary and secondary temperature monitoring, flow measurement (primary / secondary)
Heat meter integration, 0–10 V pump control

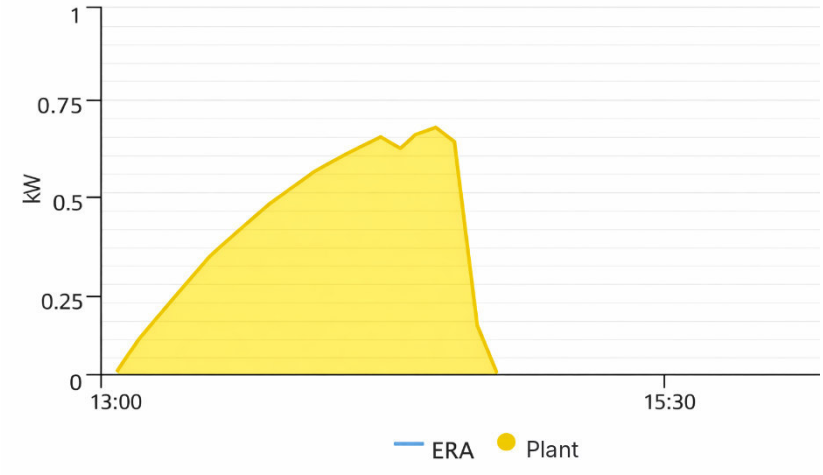


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6.1 Operational Analysis / Monitoring

Daily evaluation, description:
Daily energy generation profile
Temperature curve
Output peak
System stability





7. Safety & Operation

The system design ensures that the minimum chimney temperature of ≥ 60 °C is maintained under all operating conditions. The pressure loss calculation is carried out on a project-specific basis.

The internal boiler heat exchanger is fully retained.

Technical Scenario – smartE5 ERS

System: Heizomat biomass boiler + smartE5 ERS Energy Cube

Variant: HT upstream stage (internal heat exchanger retained)

Thermal oil: 240 °C supply / 180 °C return (ΔT = 60 K)

1. Basis

1 heat exchanger module (HX) requires 17.15 kW of thermal waste heat.

Electrical output per HX: 1.029 kWel.

Electrical conversion share: 6.0 %.

Useful heat share: 90.0 %.

2. Modular Configurations (1–40 HX)

1 HX → 17.15 kWth | 1.03 kWel | 15.43 kW useful heat

5 HX → 85.75 kWth | 5.14 kWel | 77.17 kW useful heat

10 HX → 171.5 kWth | 10.29 kWel | 154.35 kW useful heat

20 HX → 343.0 kWth | 20.58 kWel | 308.7 kW useful heat

40 HX → 686.0 kWth | 41.16 kWel | 617.4 kW useful heat

3. Thermal Oil Calculation

Formulae:

$\dot{m} = Q / (cp \times \Delta T)$

$\dot{V} = (\dot{m} / \rho) \times 3{,}600$

Example 40 HX (Q = 686.0 kWth):

$\dot{m} = 5.72$ kg/s

$\dot{V} = 24.21$ m³/h

4. Integration Principle

Flue gas is extracted downstream of the combustion chamber and upstream of the internal register passes. Partial-flow bypass with control damper. Return upstream of the induced-draught fan. Minimum chimney temperature ≥ 60 °C.

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smartE5 Energy Recovery System
ERS Cube 640
Technical Data Sheet

Performance figures as a function of the energy input

No. of HX	Thermal output (kWth)	Electrical output (kWel)	Useful heat (kWth)	Oil mass flow (kg/s)	Oil volume flow (m³/h)
1,00	17,15	1,03	15,44	0,14	0,61
2,00	34,30	2,06	30,87	0,29	1,21
3,00	51,45	3,09	46,31	0,43	1,82
4,00	68,60	4,12	61,74	0,57	2,42
5,00	85,75	5,15	77,18	0,71	3,03
6,00	102,90	6,17	92,61	0,86	3,63
7,00	120,05	7,20	108,05	1,00	4,24
8,00	137,20	8,23	123,48	1,14	4,84
9,00	154,35	9,26	138,92	1,29	5,45
10,00	171,50	10,29	154,35	1,43	6,05
11,00	188,65	11,32	169,79	1,57	6,66
12,00	205,80	12,35	185,22	1,72	7,26
13,00	222,95	13,38	200,66	1,86	7,87
14,00	240,10	14,41	216,09	2,00	8,47
15,00	257,25	15,44	231,53	2,14	9,08
16,00	274,40	16,46	246,96	2,29	9,68
17,00	291,55	17,49	262,40	2,43	10,29
18,00	308,70	18,52	277,83	2,57	10,90
19,00	325,85	19,55	293,27	2,72	11,50
20,00	343,00	20,58	308,70	2,86	12,11
21,00	360,15	21,61	324,14	3,00	12,71
22,00	377,30	22,64	339,57	3,14	13,32
23,00	394,45	23,67	355,01	3,29	13,92
24,00	411,60	24,70	370,44	3,43	14,53
25,00	428,75	25,73	385,88	3,57	15,13
26,00	445,90	26,75	401,31	3,72	15,74
27,00	463,05	27,78	416,75	3,86	16,34
28,00	480,20	28,81	432,18	4,00	16,95
29,00	497,35	29,84	447,62	4,14	17,55
30,00	514,50	30,87	463,05	4,29	18,16
31,00	531,65	31,90	478,49	4,43	18,76
32,00	548,80	32,93	493,92	4,57	19,37
33,00	565,95	33,96	509,36	4,72	19,97
34,00	583,10	34,99	524,79	4,86	20,58
35,00	600,25	36,02	540,23	5,00	21,19
36,00	617,40	37,04	555,66	5,15	21,79
37,00	634,55	38,07	571,10	5,29	22,40
38,00	651,70	39,10	586,53	5,43	23,00
39,00	668,85	40,13	601,97	5,57	23,61
40,00	686,00	41,16	617,40	5,72	24,21

ERS output from flue gas / bypass heat recovery – scenario table (8 %) systemic waste heat losses

Practical parameters (editable)	
Operating hours per year (h/a)	8.000
Minimum chimney temperature downstream of ERS	150
Thermal oil temperature drop ΔT for power	10
Water temperature rise ΔT for heat utilisation (K) –	10
Split of recoverable heat: electricity share	6%
Split of recoverable heat: usable heat (water, low	90%



Model	Rated heat output kW_th	Recoverable 8 % (conservative) kW_th	ERS electricity 6 % of recovered kW_el	ERS usable heat 90 % of recovered kW_th	Water volume flow (m³/h) at ΔT = parameter	ERS electricity MWh_el/a	ERS heat MWh_th/a	Comment
C0	49,00	3,92	0,24	3,53	0,30	1,88	28,22	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C1	88,00	7,04	0,42	6,34	0,54	3,38	50,69	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C1L	120,00	9,60	0,58	8,64	0,74	4,61	69,12	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C2	180,00	14,40	0,86	12,96	1,11	6,91	103,68	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C3	275,00	22,00	1,32	19,80	1,70	10,56	158,40	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C4	450,00	36,00	2,16	32,40	2,79	17,28	259,20	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C5	600,00	48,00	2,88	43,20	3,72	23,04	345,60	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C6	800,00	64,00	3,84	57,60	4,95	30,72	460,80	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C6L	950,00	76,00	4,56	68,40	5,88	36,48	547,20	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.

Note: The percentages (8/15/20 %) are conservative scenarios for the recoverable flue gas / bypass heat potential relative to the rated heat output. Actual values depend on factors including flue gas mass flow, flue gas temperatures, λ, fuel moisture, part load and boiler design. The minimum chimney temperature is a guide value and must be boiler manufacturer.

Checkpoint for the boiler manufacturer (for coordination / data sheet request)

1) Minimum chimney temperature after the additional ERS flue gas heat exchanger: the flue gas leaving the ERS must not lower the chimney temperature below the minimum value specified by the manufacturer (guide value here: 150 °C; depending on fuel, dew point, material, design, part load). **2) Manufacturer data required for sizing / integration:**

flue gas temperatures per pass / flue outlet, flue gas mass flow (Nm³/h or kg/h), λ (excess air), permissible pressure losses, material / corrosion protection.

ERS output from flue gas / bypass heat recovery – scenario table (15 %) systemic waste heat losses

Practical parameters (editable)	
Operating hours per year (h/a)	8.000
Minimum chimney temperature downstream of ERS	150
Thermal oil temperature drop ΔT for power	10
Water temperature rise ΔT for heat utilisation (K) –	10
Split of recoverable heat: electricity share	6%
Split of recoverable heat: usable heat (water, low	90%



Model	Rated heat output kW_th	Recoverable 15 % (base case) kW_th	ERS electricity 6 % of recovered kW_el	ERS usable heat 90 % of recovered kW_th	Water volume flow (m³/h) at ΔT = parameter	ERS electricity MWh_el/a	ERS heat MWh_th/a	Comment
C0	49,00	7,35	0,44	6,62	0,57	3,53	52,92	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C1	88,00	13,20	0,79	11,88	1,02	6,34	95,04	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C1L	120,00	18,00	1,08	16,20	1,39	8,64	129,60	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C2	180,00	27,00	1,62	24,30	2,09	12,96	194,40	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C3	275,00	41,25	2,48	37,13	3,19	19,80	297,00	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C4	450,00	67,50	4,05	60,75	5,22	32,40	486,00	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C5	600,00	90,00	5,40	81,00	6,97	43,20	648,00	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C6	800,00	120,00	7,20	108,00	9,29	57,60	864,00	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C6L	950,00	142,50	8,55	128,25	11,03	68,40	1.026,00	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.

Note: The percentages (8/15/20 %) are conservative scenarios for the recoverable flue gas / bypass heat potential relative to the rated heat output. Actual values depend on factors including flue gas mass flow, flue gas temperatures, λ, fuel moisture, part load and boiler design. The minimum chimney temperature is a guide value and must be boiler manufacturer.

Checkpoint for the boiler manufacturer (for coordination / data sheet request)

1) Minimum chimney temperature after the additional ERS flue gas heat exchanger: the flue gas leaving the ERS must not lower the chimney temperature below the minimum value specified by the manufacturer (guide value here: 150 °C; depending on fuel, dew point, material, design, part load). **2) Manufacturer data required for sizing / integration:**

flue gas temperatures per pass / flue outlet, flue gas mass flow (Nm³/h or kg/h), λ (excess air), permissible pressure losses, material / corrosion protection.

ERS output from flue gas / bypass heat recovery – scenario table (20 %) systemic waste heat losses

Practical parameters (editable)	
Operating hours per year (h/a)	8.000
Minimum chimney temperature downstream of ERS	150
Thermal oil temperature drop ΔT for power	10
Water temperature rise ΔT for heat utilisation (K) –	10
Split of recoverable heat: electricity share	6%
Split of recoverable heat: usable heat (water, low	90%

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Model	Rated heat output kW_th	Recoverable 20 % (upper case) kW_th	ERS electricity 6 % of recovered kW_el	ERS usable heat 90 % of recovered kW_th	Water volume flow (m³/h) at ΔT = parameter	ERS electricity MWh_el/a	ERS heat MWh_th/a	Comment
C0	49,00	9,80	0,59	8,82	0,76	4,70	70,56	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C1	88,00	17,60	1,06	15,84	1,36	8,45	126,72	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C1L	120,00	24,00	1,44	21,60	1,86	11,52	172,80	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C2	180,00	36,00	2,16	32,40	2,79	17,28	259,20	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C3	275,00	55,00	3,30	49,50	4,26	26,40	396,00	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C4	450,00	90,00	5,40	81,00	6,97	43,20	648,00	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C5	600,00	120,00	7,20	108,00	9,29	57,60	864,00	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C6	800,00	160,00	9,60	144,00	12,38	76,80	1.152,00	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.
C6L	950,00	190,00	11,40	171,00	14,71	91,20	1.368,00	Ökotherm Compact units; recovery share as scenario. Volume flow at ΔT from parameter cell.

Note: The percentages (8/15/20 %) are conservative scenarios for the recoverable flue gas / bypass heat potential relative to the rated heat output. Actual values depend on factors including flue gas mass flow, flue gas temperatures, λ, fuel moisture, part load and boiler design. The minimum chimney temperature is a guide value and must be boiler manufacturer.

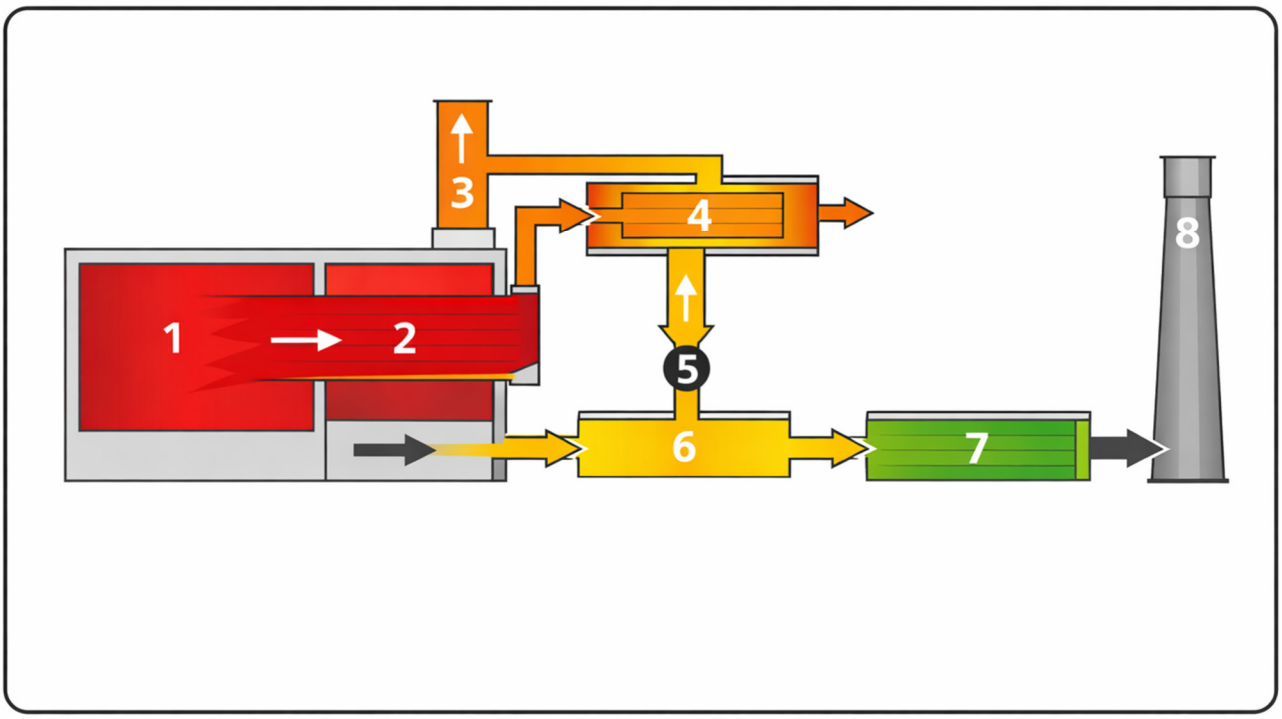
Checkpoint for the boiler manufacturer (for coordination / data sheet request)

1) Minimum chimney temperature after the additional ERS flue gas heat exchanger: the flue gas leaving the ERS must not lower the chimney temperature below the minimum value specified by the manufacturer (guide value here: 150 °C; depending on fuel, dew point, material, design, part load). **2) Manufacturer data required for sizing / integration:**

flue gas temperatures per pass / flue outlet, flue gas mass flow (Nm³/h or kg/h), λ (excess air), permissible pressure losses, material / corrosion protection.

Project ERS OEM V2 – Legend & Technical Description

System: smartE5 ERS bypass heat exchanger (HT upstream stage)
Reference boiler: Heizomat RHK-AK – 1000 kW
Thermal oil: 240 °C / 180 °C (ΔT = 60 K)



1. Legend (diagram reference 1–8)

1 – Combustion chamber / furnace (pass 1 inlet)

2 – First flue gas pass (high-temperature zone)

3 – Bypass branch to the ERS system

4 – smartE5 ERS bypass heat exchanger (HT stage)

5 – Return to the main flue gas stream (upstream of pass 2)

6 – Second flue gas pass

7 – Internal boiler heat exchanger (standard register)

8 – Chimney / stack

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2. Technical System Description

The smartE5 ERS system is integrated as a high-temperature bypass heat exchanger between the first and second flue gas passes. A defined partial flow of the flue gas is branched off after the first pass, routed through the ERS heat exchanger and then returned to the main stream before it enters the second pass.

The boiler's internal heat exchanger is fully retained. The ERS system operates as an upstream thermal stage and reduces the thermal load on the downstream heating surfaces.

Thermal output per heat exchanger module: 17.15 kW
Electrical output per module: 1.029 kW
Maximum configuration (Cube 640 – 40 HX):
686 kW thermal
41.16 kW electrical

3. Note on Pressure Loss

Integrating the ERS bypass system introduces additional flow resistance in the flue gas path. Plant operation must be designed so that the required chimney draught of 10 Pa is maintained at full load.

The pressure loss calculation must be performed on a project-specific basis, taking into account the flue gas mass flow of 603 g/s.

4. Note on Chimney and Temperature Control

In the reference case, the flue gas temperature downstream of the internal register is approx. 120 °C. A minimum chimney temperature of ≥ 60 °C must be maintained at all times to prevent condensation and chimney sooting (condensate deposits).

The ERS output control must be designed so that the minimum temperature at the chimney outlet is ensured under all operating conditions.

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